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ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Judging Ripeness of Seeds in Black Hills Ponderosa Pine Cones

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Buoyancy of cones in water is a good indicator of cone and seed ripeness for ponderosa pine in the Black Hills. When more than half of the cones in a sample from several trees will float, cones in that vicinity should yield a satisfactory number of viable seeds. Frequent checks on specific gravity are needed from mid-August on, since ripening proceeds rapidly then.

Keywords: *Pinus ponderosa* var. *scopulorum*, seed ripeness, forest seed collecting.

Collecting cones from standing trees is a difficult and time-consuming task. There is only a brief period between times of earliest seed ripeness and the beginning of seed fall. In many years, squirrels compound the problem with their early-season cone cutting.

It is important, then, to be able to determine the earliest practical time to begin collecting cones so as to maximize the period when viable seed in sufficient quantities can be obtained. This Note presents a guide to help the manager decide when to begin his collection.

Background Information

Useful indexes of seed maturity in the pines are usually determined indirectly by some measurement of the cone. The ratio of weight to volume (specific gravity) of freshly picked cones is commonly used to estimate ripeness of the seeds contained. Maki (1940) and Fowells and Schubert (1956) related specific gravity to seed ripeness for ponderosa pine in central Idaho and the pine region of California. While specific gravity is a valid indicator of seed ripeness in the Black Hills also, the critical values used elsewhere (0.84 and 0.86) appear too low for this region.

Other methods for estimating seed ripeness or maturity — such as percent moisture content of the cones, cone color, or splitting the cone to observe degree of milkiness or hardness of seeds — all appear too variable or impractical for field use in the Black Hills.

Study Methods

Cones were collected at 1- to 3-week intervals during the ripening period in 1970 and 1971

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from trees at three widely separated locations in the Black Hills National Forest. Collection areas were in the southern Hills, north-central Hills, and Bear Lodge Mountains (fig. 1).

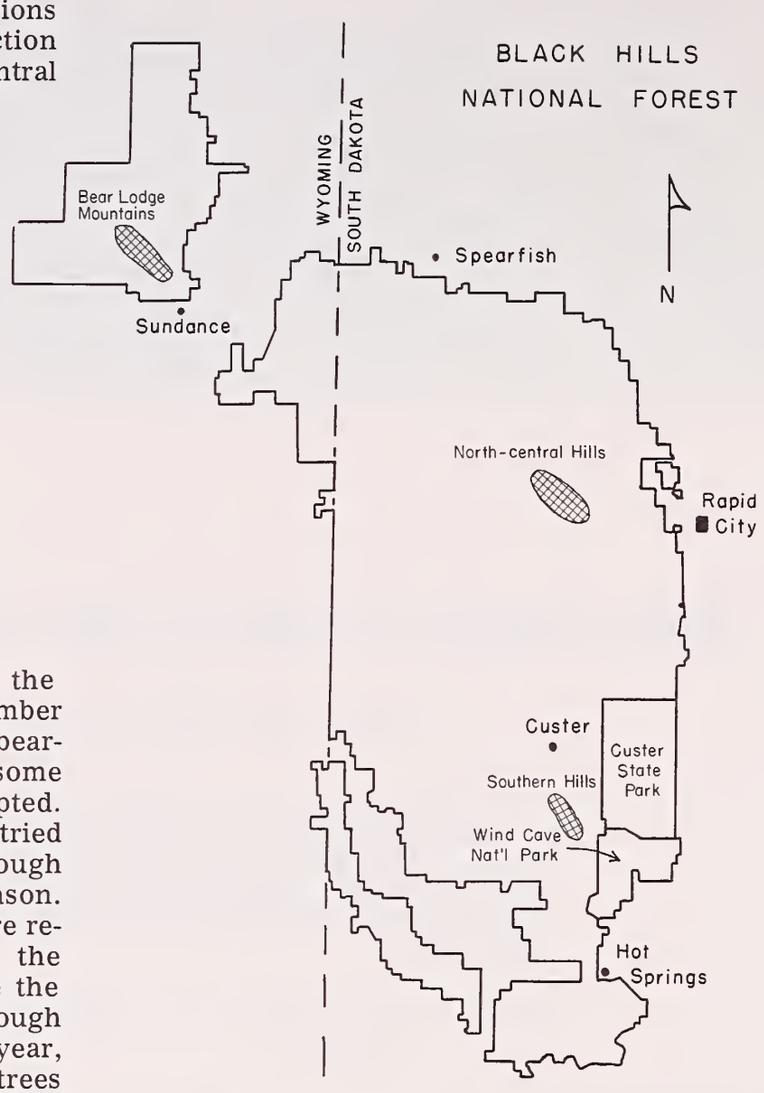

Figure 1.—Location of sampling areas for Black Hills ponderosa pine cone collections.

Sample trees. — Most were typical of the kind of trees silviculturists prefer for timber production. However, in cases where cone-bearing trees of top quality were lacking, some prolific trees of poorer form were accepted. Before cones were collected each year, we tried to select sample trees which contained enough cones to last throughout the collection season. Nevertheless, in each area a few trees were replaced by others nearby when crops on the original selections were exhausted before the season's collections were completed. Although the same three areas were sampled each year, the bulk of the cones came from different trees in the two years. Most trees sampled in 1970 produced few cones in 1971.

Collection of cones. — Size and frequency of collections were similar but not identical in the 2 years. Fifty cones (10 per tree) were collected from each area on each of three dates in 1970 — 450 cones in all. In 1971, 35 cones (seven per tree) were picked per area on each of six dates — or 630 cones total. All cones were picked from the upper half of tree crowns, and all were free of visible abnormalities — they would have been accepted by regular cone collectors.

Laboratory and greenhouse. — After each collection, the cones were brought quickly to the laboratory where they were weighed and their volumes determined by water displacement. Each year, 25 cones from each collection date and area were stored overwinter in individual paper bags in a heated room. Each spring seeds were extracted from open cones by shaking; unopened cones were not dissected to remove seeds.

Half of the cones collected in 1970 were ovendried to determine their moisture content at the time of collection. In 1971, moisture contents were determined for only 10 cones per collection area and data. No germination tests were made using seed from ovendried cones.

Extracted seeds were bulked by date and collection area before their germination was tested. In 1970, all seeds extracted were tested. The following year, tests were limited to 576 seeds from each area and date, except for some early-season collections which yielded fewer seeds (table 1).

Table 1.--Results of seed germination tests and some related cone characteristics for 25-cone samples of ponderosa pine in the Black Hills and Bear Lodge Mountains

Collection area	1970 COLLECTIONS						1971 COLLECTIONS					
	Date of collection	Average specific gravity	Cones with specific gravity of 1.000 or less	Cones opening overwinter in heated room	Seeds tested for germination	Germination	Date of collection	Average specific gravity	Cones with specific gravity of 1.000 or less	Cones opening overwinter in heated room	Seeds tested for germination	Germination
			Number			*Percent*						*Percent*
Bear Lodge Mountains	Aug. 11	1.000	10	0	[1]	--	Aug. 3	0.986	20	1	16	0.0
	Aug. 24	.987	14	10	396	68.9	Aug. 13	1.007	4	11	279	49.8
	Sept. 9	.980	19	19	720	52.1	Aug. 23	.990	17	21	576	39.4
							Sept. 3	.958	18	25	576	32.1
							Sept. 15	.937	25	25	576	21.9
							Oct. 6	.828	25	24	576	22.7
North-central Hills	Aug. 10	1.021	2	5	230	69.6	Aug. 4	.996	11	1	26	0.0
	Aug. 21	1.027	0	6	210	32.9	Aug. 12	1.019	3	9	252	5.6
	Sept. 8	.965	19	23	998	54.9	Aug. 25	1.017	5	14	576	34.2
							Sept. 2	.970	16	19	576	63.7
							Sept. 14	.954	18	20	576	39.9
							Oct. 5	.819	25	25	576	37.7
Southern Hills	Aug. 7	1.019	2	1	44	0.0	Aug. 2	1.024	0	2	36	0.0
	Aug. 21	1.002	8	11	383	46.7	Aug. 12	1.027	0	4	[1]	--
	Sept. 8	.943	25	19	648	50.6	Aug. 25	1.027	0	7	252	20.6
							Sept. 2	1.017	1	7	240	63.8
							Sept. 14	.990	13	20	576	56.6
							Oct. 5	.823	25	25	576	54.0

[1] Too few seeds were available for germination tests.

Results and Discussion

Specific gravity of fresh cones as an index of maturity. — When 50 to 60 percent (12-15 cones) of a 25-cone sample from an area will float in water, it is probably safe to start collections in that area. By that time, most of the cones can be expected to open naturally, and yield seed with viability as good as seed collected at any later date (table 1).

One glaring and one marginal inconsistency appeared in 1971 which might have lead collectors to pick cones before they were ripe in two of the three areas. On August 3, in the Bear Lodge Mountains, 20 out of 25 cones (80 percent) would have floated in water, indicating satisfactory seed ripeness. It was not until August 23, however, that cones were ripe enough for picking in the Bear Lodge Mountains (table 1).

An overzealous collector might have started picking cones on August 4 in the north-central Hills if he had been willing to accept 11 floating cones instead of the suggested 12 to 15 in his 25-cone sample (table 1). He could have understandably reasoned that ripening would probably proceed faster than his collecting. But it was not until September 2 that the sample met the minimum specific gravity criterion for that area.

Some relatively high germination percentages were found for samples of seeds collected before average specific gravities declined to 1.000. In the north-central Hills collection of August 10, 1971 (table 1), for example, seed viability was good, but seed yield was low because only 20 percent of the cones opened.

In this study, germination did not increase steadily with progress of season as reported for white pine (Jones, Massello, and Clifford 1967) and for ponderosa pine (Maki 1940). Part of the reason for lack of a distinct ripening trend may be that, in this study, completely or partially closed cones were not dissected to extract seeds that they would not give up naturally. Thus, samples with relatively high germination percentages but small numbers of naturally opened cones may have been made up mostly of seeds that were physiologically ready to germinate, while other unopened cone scales retained seeds that were mostly immature.

Absolute values for germination of seeds in these 2 years are not as high as have been found for Black Hills ponderosa pine in some other tests. For example, seeds collected in 1967 throughout the Black Hills showed an average germination of 85 to 90 percent in standard tests at the Eastern Tree Seed Laboratory.

At least three factors, singly or in combination, may have accounted for the lower germination percentages in this study: Overwinter storage in a heated room could have affected seed viability; conditions in the greenhouse during germination tests may not have been as favorable as at the Seed Laboratory; or a variation in average viability from one seed year to another may have been a natural cause for lower germination.

On the other hand, the results of this study compare favorably with those of Bates' studies of seed production and viability in the southern Black Hills from 1912-24.[2] He found an overall

[2] *Unpublished data on file at Rocky Mt. For. and Range Exp. Stn., Rapid City, S. Dak.*

average germination of 49 percent for all seeds collected during the period. The best germination he observed for an annual crop was only 67 percent. The poorest for a year of high production was about 30 percent.

Results from 1970 (table 1) indicate desirability of frequent checks on cone condition. Collections from the Bear Lodge Mountains probably were made just before a critical turning point in maturation. More frequent collections would probably have identified earlier acceptable collection dates for the other areas.

Table 1 also shows a trend of cone ripening which progresses from north to south. The trend is especially noticeable in 1971 because of more frequent collections. The warmer climate in the south apparently prolongs the growing season, with consequent later maturity dates.

Percent moisture content of cones. — Maturation of pine cones and seeds involves, in part, drying of their tissues. Moisture content of cones can be used as an indication of cone and seed ripeness, but it is not readily determined in the field, at least when ovendrying is used. Figure 2 shows the general downward trend of average percent moisture of cones (including seeds) over time. We have no explanation other than biological variation to account for cones from the Bear Lodge Mountains having a higher average moisture content September 10 than August 24, 1970. A range in average moisture contents of 120 to 140 percent includes most cones that are ready for harvest. Average moisture contents for cones from the three areas were relatively close when the cones first reached harvestable condition.

Moisture content of cones at time of seed ripeness can vary greatly between species. Jones, Massello, and Clifford (1967) reported an average moisture content of 232 percent when seeds from their white pine cones first reached acceptable germination levels.

Conclusions

Specific gravity (fresh weight basis) is a usable criterion for estimating ripeness of Black Hills ponderosa pine cones and seeds. Although only three areas were sampled in each of 2 years, they covered the range of conditions likely to be encountered by Black Hills cone collectors. When 12 to 15 cones out of a 25-cone sample will float in water, the cones in that vicinity will probably yield a satisfactory quantity of viable seeds.

Inconsistencies in the relationship between specific gravity and seed ripeness early in August lead us to recommend that collectors wait until mid-August before checking cone specific gravities. In practice, cones to be float-tested should come from five or more trees in the area from which collections are to be made. Frequent checks, at no more than weekly intervals, should be made from mid-August on, since cone and seed ripening appears to progress rapidly at that time.

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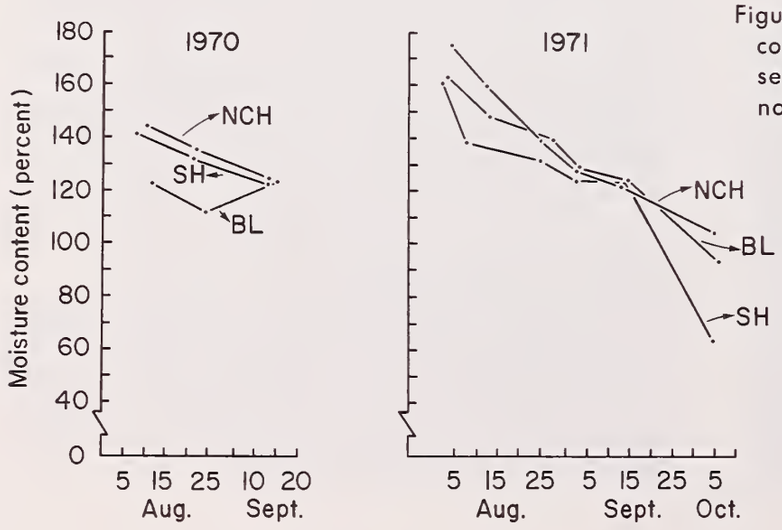

Figure 2.—Average moisture content of ponderosa pine cones collected at periodic intervals during two consecutive years from the Bear Lodge Mountains (BL), north-central Hills (NCH), and southern Hills (SH).